

Claims

- 1 A disposable pump unit for receiving and metering a predetermined volume of fluid, the pump comprising a body having a surface at which opens the mouth of a cavity formed in the body, an inlet port for the fluid opening at the surface adjacent to the mouth of the cavity whereby, when the inlet port is open, fluid can flow from the inlet port into the cavity *via* the mouth thereof, a first flexible membrane sealingly secured at its periphery to the surface and overlying the cavity and the inlet port, an outlet port for the fluid , there being a fluid flow passageway extending through the body connecting the cavity to the outlet port, and a second flexible membrane sealingly secured at its periphery and overlying the outlet port, those portions of the first and second flexible membranes, where they overlie the inlet and outlet ports respectively, serving as closures for the ports.
- 15 2 A disposable pump unit according to Claim 1 wherein the outlet port also opens at the same surface at which opens the mouth of the cavity and the first and second flexible membranes are integral with one another.
- 20 3 A disposable pump unit according to Claims 1 or Claim 2 wherein the flexible membrane which overlies the cavity and the inlet port is substantially non-stretchable and is pre-formed to a shape substantially similar to the shape of the surface of the pump cavity such that, during the fluid metering step, it can be urged by the actuating fluid into contact with substantially the whole surface of the cavity wall whereby substantially all of the fluid drawn from the reservoir during the fluid filling step is pumped out during the fluid metering step.
- 25 4 A disposable pump unit according to claim 3 wherein during storage and transportation the preformed shape of the membrane lies flush with the concavely curved surface of the pump cavity thereby reducing the susceptibility of the membrane to damage during transit.

- 5 A disposable pump unit according to any one of Claims 1 to 4 wherein the flexible membranes comprise a laminate flexible film comprising a layer of a substantially non-stretchable polymer, and a layer of a heat-weldable polymer.
- 5 6 A disposable pump unit according to Claim 5 wherein the flexible membranes comprise a layer of polyamide and a layer of polyurethane.
- 7 A disposable pump unit according to any one of claims 1 to 6 wherein downstream of the cavity there is a variable flow restrictor.
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- 8 A disposable pump unit according to any of claims 1 to 7 wherein a plurality of cavities each having respective inlet ports, outlet ports and flexible membranes are provided whereby, when coupled to a pump actuator, fluid may be drawn into at least one of the cavities whilst simultaneously being pumped out of at least one other another.
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- 9 A pump unit according to Claim 8 comprising a pair of cavities.
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- 10 A disposable pump unit according to any one of claims 1 to 9 wherein, in the surface of the cavity there is formed therein a plurality of passageways that communicate with the fluid flow passageway thereby to inhibit, during the fluid metering step, the formation of occluded regions of fluid between the cavity wall and the first flexible membrane and thus ensure that substantially all of the fluid drawn from the reservoir thereof during the fluid filling step is pumped out during the fluid metering step thereby ensuring a substantially repeatable volume of fluid is dispensed each time.
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- 11 A disposable pump unit according to Claim 10 wherein each of the plurality of passageways is a groove.
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- 12 A disposable pump unit according to any one of claims 1 to 11 further comprising, downstream of the outlet port(s), a chamber having a diluent inlet and a
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diluted fluid outlet whereby the pumped fluid mixes with a diluent before exiting the disposable pump unit.

13 A disposable pump unit according to Claim 12 wherein between the outlet port(s) and the diluent inlet are provided a number of obstructions in the flow to break up of the pumped fluid to aid admixture to diluent.

14 A disposable pump unit according to Claims 12 or 13 wherein the outlet passageway includes a mixing means.

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15 A disposable pump unit according to Claim 14 wherein the mixing means is a static mixer through which the admixture flows.

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16 A disposable pump unit according to any one of claims 1 to 15 wherein the disposable pump unit is connected to, or integral with, a disposable reservoir containing the fluid so that, in use, once the reservoir is empty or otherwise needs to be changed, the combined reservoir and pump unit may be disposed of.

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17 A disposable pump unit and reservoir according to Claim 16 wherein an openable closure is provided between the disposable pump unit and the reservoir such that the reservoir and disposable pump unit may be shipped together whilst preventing the migration of the fluid into the disposable pump unit.

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18 A disposable pump unit according to any one of claims 1 to 17 including identification means such that, in use, a re-usable pump actuator coupled to the disposable pump unit automatically reads information comprised in the identification means whereby the combined pump/pump actuator may adapt its mode of operation dependant upon the information identified.

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19 A disposable pump unit according to Claim 18 wherein the identification means of the disposable pump unit is capable of receiving and storing information from the re-usable pump actuator.

20 A disposable pump unit according to Claim 18 or Claim 19 wherein the identification means is a radio frequency identification (RFID) tag or an Electro-Erasable-Programmable-Read Only Memory (EEPROM) chip.

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21 A disposable pump unit according to Claim 8 or any claim appendant thereto wherein cavities of the disposable pump unit are connected via their respective inlet ports to respective sources of different fluids and the outlet ports join together to form a common outlet associated with the cavities, whereby the respective fluids may, in 10 association with a re-usable pump actuator, be dispensed simultaneously and mixed together.

22 The combination of a disposable pump unit according to any one of claims 1 to 21 and, detachably coupled thereto, a re-usable pump actuator, with the said 15 surface of the disposable pump unit sealingly abutting the pump actuator, the pump actuator comprising: a source of positive and negative pressure actuating fluid, and first and second valve actuating means, each having an associated actuator, associated respectively with the inlet port closure and the outlet port closure, the arrangement being such that, when the external surface of the first flexible membrane is exposed to 20 the source of negative pressure fluid, with the inlet port open and the outlet port closed, it is drawn away from the disposable pump body whereby fluid is drawn, from a reservoir thereof *via* the inlet port, into substantially all of the space defined by the cavity and the first flexible membrane and, with the inlet port closed and the outlet port open, when positive pressure fluid is applied to the external surface of the 25 first flexible membrane, the membrane is urged back towards and into the cavity and pumps the fluid from the cavity through the said passageway to the outlet port.

23 The combination according to Claim 22 wherein the first and second valve actuating means are axially movable armatures.

- 24 The combination according to Claim 22 or Claim 23 wherein the actuator associated with the outlet port closure armature is driven by a stepper motor such that the opening of the outlet port can be varied to provide a variable flow restriction.
- 5 25 The combination according to Claim 23 or Claim 24 wherein seals are provided around the armatures associated with at least the inlet port preventing any substance from passing the armature towards the actuator.
- 10 26 The combination according to any one of claims 22 to 25 wherein the reusable pump actuator has recesses therein such that when coupled to the disposable pump unit the pumped volume is defined on one side by the wall of the pump cavity, and on the other side by the wall of the recess in the pump actuator.
- 15 27 The combination according to Claim 26 wherein the armature associated with the inlet port extends into the volume between the recess and the flexible membrane of the disposable pump unit.
- 20 28 The combination according to any one of claims 22 to 27 wherein a means of detecting whether the or each recess is full or empty is provide in or on the pump actuator
- 29 The combination according to Claim 28 wherein the detecting means are ultrasonic detection means.
- 25 30 A reusable pump actuator as defined in any of claims 22 to 29 for use in combination with a disposable pump unit as defined in any one of claims 1 to 21.